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A summary report is presented of the emission inventory for the New York State Southern Tier West Area. The report provides estimates of the present levels of air pollutant emissions and status of their control. The pollutants which include sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides are delineated with respect to source type, season of the year, and geographical distribution within the area. The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of seven counties in southwest New York. A grid coordinate system was used to show the geographical distribution of emissions within counties. All sources of emissions were classified into five categories: transportation, stationary fuel combustion, solid-waste disposal, industrial processes, and evaporative losses.

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NEW YORK STATE SOUTHERN TIER WEST

EMISSION INVENTORY

Prepared by

James R. Beaty

ENVIRONMENTAL PROTECTION AGENCY

Air Pollution Control Office

Durham, North Carolina

February, 1971

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PREFACE

This report, which presents the emission inventory for the New York State Southern Tier West Area, is another in a series of surveys outlining the sources and emissions of air pollutants for major areas in the country. These surveys, conducted by the National Inventory of Air Pollutant Emissions and Control Branch of the Air Pollution Control Office, provide estimates of the present levels of air pollutant emissions and status of their control. The pollutants which include sulfur oxides, particulates, carbon monoxide, hydrocarbons and nitrogen oxides, are delineated with respect to source type, season of the year and geographical distribution within the area. The general procedure for the surveys is based upon the rapid survey technique for estimating air pollutant emissions.[1]

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INTRODUCTION

This report is a summary of the Southern Tier West air pollutant emission inventory conducted in January, 1971. Since all inventories are based upon a calendar year, the data and emission estimates presented are representative of 1970 and should be considered as indicating the conditions as existed during that year.

The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of seven counties in Southwest New York. This area covers approximately 6,000 square miles and had a 1970 population of 590,000.

A grid coordinate system was used to show the geographical distribution of emissions within counties. The Study Area was subdivided into 100 grid zones ranging in size from 25 square kilometers in the heavily populated and industrialized areas to 400 square kilometers in the rural areas.

All sources of emissions were classified into five categories—transportation, stationary fuel combustion, solid-waste disposal, industrial processes and evaporative losses. Each of these source categories was divided into two subgroups—point sources and area sources. Facilities, which emit large quantities of air pollutants, were considered individually as point sources while the many remaining contributors such as motor vehicles, residential and commercial fuel users, small industries and on-site refuse burning equipment, were considered collectively as area sources. For this report, fifty-two individual sources, which had emissions

greater than 0.1 tons per average annual day for any pollutant, were classified as point sources.

Emissions were estimated by using various indicators such as fuel consumption, refuse burning rates, vehicle-miles, production data, and control efficiencies and emission factors relating these indicators to emission rates.[2] These factors represent average emission rates for a particular source category. Since individual sources have inherent differences that cannot always be taken into consideration, discrepancies between the actual and estimated emissions are more likely in individual sources than in the total emissions from a source category.

As in all emission surveys, the data presented are estimates and should not be interpreted as absolute values. The estimates are, in some cases, partial totals due to the lack of emission factors and production or consumption data. Despite these limitations, these estimates are of sufficient accuracy and validity in defining the extent and distribution of air pollutant emissions in the Study Area.

SUMMARY OF RESULTS

The annual emission estimates (tons/year) for the New York Southern Tier West Air Pollutant Emission Inventory Are:

Sulfur Oxides	166,700
Particulates	43,500
Carbon Monoxide	215,700
Hydrocarbons	40,000
Nitrogen Oxides	50,800

The following is a brief description of the air pollutant emissions as presented in Table 1 and Table 2.

Sulfur Oxides: The largest portion of the sulfur oxides emitted came from the four steam-electric plants located in the Study Area which had coal fired units. Together these plants accounted for 54 percent of total sulfur oxides. The combustion of fossil fuels by other stationary sources accounted for 45 percent of the sulfur oxides emitted. The remainder was distributed under motor vehicles, refuse disposal and small industries.

Particulates: The majority of the particulate emissions (52%) came from the combustion of coal at the four power plants in the Study Area. Individual sources of particulates from industrial processes accounted for

Particulates: (continued)

12 percent of total particulate emissions. The largest sources from industrial processes were plants in the mineral products industry, which accounted for 7 of this 12 percent. The combustion of coal by industrial sources was the only other significant source of particulates, accounting for 18 percent of the total.

Carbon Monoxide:

In most metropolitan areas the largest source of carbon monoxide emissions is from automobiles and other motor vehicles. This was also true in the Study Area as motor vehicles contributed 83 percent of the carbon monoxide emitted annually. Other transportation sources including railroad and aircraft operations contributed another 1 percent. The only other significant sources of carbon monoxide were from the inefficient combustion of refuse at open burning dumps and industrial process losses. These categories accounted for about 4 and 5 percent respectively of the total emissions.

Hydrocarbons:

Exhaust gases from motor vehicles was the primary source of hydrocarbon emissions, accounting for 37 percent of the total. Evaporative losses from motor vehicles which includes losses from the gas tank, carburetor and engine crankcase accounted

Hydrocarbons: (continued)

for 29 percent of total hydrocarbon emissions. Other smaller evaporative loss sources including gasoline storage and handling, industrial solvent usage, dry cleaning plants, and miscellaneous solvent usage, collectively accounted for 16 percent of total emissions. Other sources included the open burning of solid waste, railroad and aircraft operations, and stationary fuel combustion, which accounted for 9, 2 and 7 percent, respectively, of total emissions.

Nitrogen Oxides:

The largest sources of nitrogen oxides were the four steam-electric plants. The combustion of coal at these plants accounted for 44 percent of total nitrogen oxide emissions. The combustion of coal, oil, and gas at other stationary sources accounted for 27 percent of total emissions. The second largest source of nitrogen oxides was the exhaust gas from motor vehicles, which contributed almost 27 percent of the total. The remaining 2 percent of the nitrogen oxides came from the disposal of refuse by incineration and open burning and from industrial process emissions.

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN STUDY AREA, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	1,095	1,240	186,460	14,840	13,685
Other	225	220	2,290	720	265
Subtotal	1,320	1,460	188,750	15,560	13,950
Stationary Fuel Combustion					
Industry	44,000	7,770	2,880	1,240	5,990
Steam-Electric	89,610	22,380	1,260	380	22,590
Residential	3,880	1,270	1,990	510	1,560
Commercial and Institutional	27,430	3,390	1,150	560	5,680
Subtotal	164,920	34,810	7,280	2,690	35,820
Refuse Disposal					
Incineration	20	380	10	115	120
Open Burning	110	1,780	9,470	3,335	670
Subtotal	130	2,160	9,480	3,450	790
Industrial Processes	310	5,050	10,170	80	270
Evaporative Losses	—	—	—	18,200	—
GRAND TOTAL[a]	166,680	43,480	215,680	39,980	50,830

a = Totals have been rounded.

N = Negligible

TABLE 2 SUMMARY OF AIR POLLUTANT EMISSIONS IN STUDY AREA, 1970
(1,000 kg/year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbon	Nitrogen Oxides
Transportation					
Motor Vehicles	1,000	1,150	169,200	13,500	12,400
Other	200	200	2,100	650	240
Subtotal	1,200	1,350	171,300	14,150	12,640
Stationary Fuel Combustion					
Industrial	40,000	7,050	6,620	1,130	5,400
Steam-Electric	81,400	20,250	1,150	350	20,500
Residential	3,500	1,150	1,810	460	1,400
Commercial and Institutional	25,000	3,070	1,040	510	5,200
Subtotal	149,900	31,520	6,620	2,450	32,500
Refuse Disposal					
Incineration	20	350	10	105	110
Open Burning	100	1,610	8,600	3,025	610
Subtotal	120	1,960	8,610	3,130	720
Industrial Porcesses	280	4,600	9,250	70	250
Evaporative Losses	—	—	—	16,500	—
GRAND TOTAL	151,500	39,430	195,780	36,300	46,110

TABLE 3 PERCENTAGE CONTRIBUTION OF EACH SOURCE CATEGORY TO TOTAL EMISSIONS IN THE NEW YORK STUDY AREA

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbon	Nitrogen Oxides
Transportation					
Motor Vehicles	.7	2.9	86.5	37.1	26.9
Other	.1	.4	1.1	1.8	.5
Subtotal	.8	3.3	87.6	38.9	27.4
Stationary Fuel Combustion					
Industry	26.4	17.9	1.3	3.1	11.8
Steam-Electric	53.8	51.5	.6	.9	44.4
Residential	2.3	2.9	.9	1.3	3.1
Commercial and Institutional	16.5	7.8	.5	1.4	11.2
Subtotal	99.0	80.1	3.3	6.7	70.5
Refuse Disposal					
Incineration	N	.9	N	.3	.2
Open Burning	N	4.1	4.4	8.3	1.4
Subtotal	N	5.0	4.4	8.6	1.6
Process Losses	.2	11.6	4.7	.2	.5
Evaporative Losses	—	—	—	45.6	
TOTAL	100	100	100	100	100

DESCRIPTION OF STUDY AREA

The Study Area for the emission survey of the New York State Southern Tier West Area consists of seven counties - Allegany, Cattaraugus, Chautauqua, Chemung, Schuyler, Steuben, and Tompkins. The seven counties are located in the southwest portion of New York State along the Pennsylvania border. Figure 1 shows the location of the Study Area relative to other large cities in its vicinity.

Figure 2 represents a more detailed drawing of the Study Area showing the major urban areas. It should be pointed out that the boundaries of these areas do not correspond to city limits, but rather give a general outline of the major clusters of population. The study area occupies 6105 square miles and contained an estimated 1970 population of 589,540, which is approximately a 8 percent increase since 1960 (Table 4).[3] The population density map (Figure 3) shows the heaviest concentrations near the cities of Dunkirk, Jamestown, Olean, Corning, Elmira, and Ithaca.

TOPOGRAPHY: The eastern portion of the Study Area lies at the southern end of Keuka, Seneca, and Cayuga lake of the Finger Lakes. In the western half of the study area, the major lakes are Lake Erie which comprises the western border and Chautauqua Lake in Chautauqua County. Elevations range from 400 to 2,500 feet above sea level in the Study Area. The major rivers are the Canisteo, Tioga, and Chemung.

TABLE 4 AREA AND POPULATION CHARACTERISTICS FOR STUDY AREA

Political Jurisdiction	Land Area (Sq. Mi.)	Population 1960	Population 1970	Population Density (1970)
Allegary	1,048	43,980	46,630	45
Cattaraugus	1,335	80,190	81,960	61
Chautaugua	1,080	145,380	153,220	142
Chemung	412	98,700	108,200	240
Schuyler	331	15,040	15,580	45
Steuben	1,408	97,690	101,870	69
Tompkins	491	66,160	82,090	135
GRAND TOTAL	6,105	547,150	589,550	92

Figure 1. Map of study area and surrounding cities.

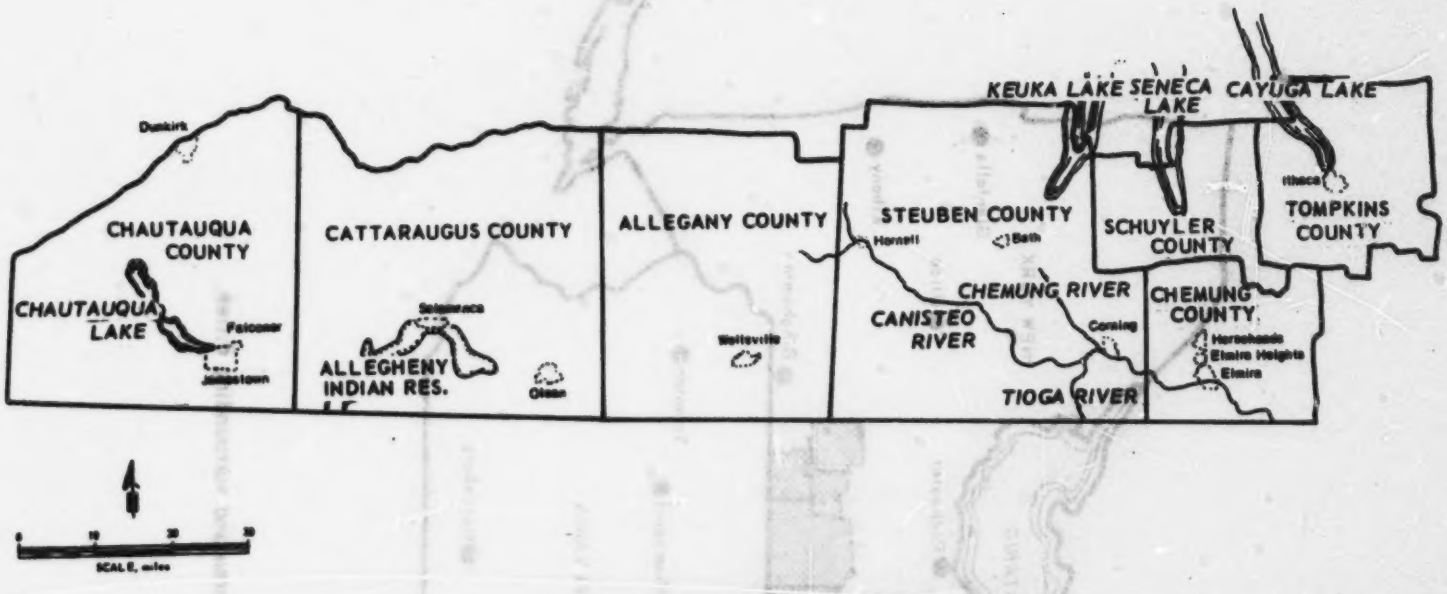

Figure 2. Detailed map of study area.

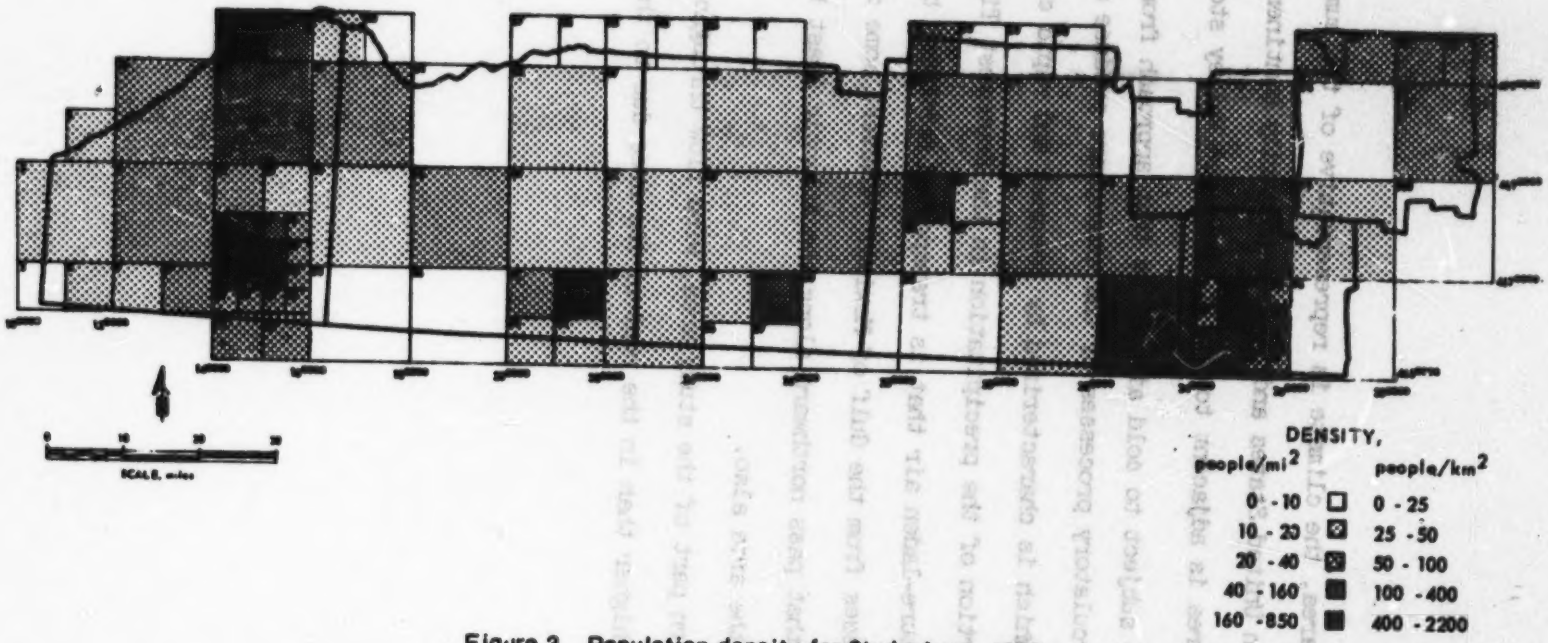

Figure 3. Population density for Study Area, 1970.

CLIMATOLOGY[4]

In the study area, the climate is representative of the humid area of the Northeastern United States and is also primarily continental in type. Since the area is adjacent to the St. Lawrence Valley storm-track, and is also subject to cold air masses that approach from the west and north, the circulatory processes of the atmosphere produce a variable climate which is characterized by frequent and rapid changes.

The major portion of the precipitation in the Southwest Tier derives from moisture-laden air that is transported northward by atmospheric processes from the Gulf of Mexico. However, some of the cyclonic systems that pass northward along the Atlantic Coast bring precipitation to the area also.

In the western part of the study area, wind flow throughout the year is somewhat higher than in the rest of the area due to the proximity of Lake Erie.

GRID COORDINATE SYSTEM

A grid coordinate system, based on the Universal Transverse Mercator Projection (UTM) was used in the Southern Tier Study Area to show the geographical distribution of emissions. A map of this grid system is presented in Figure 4.

The UTM system was chosen due to its advantages over other standard grid systems such as the Latitude-Longitude and State Plane Coordinate Systems. The major advantages of this system are that (1) it is continuous across the country and is not hindered by political subdivisions, (2) the grids are of uniform size throughout the country, (3) it has world-wide use, and (4) the grids are square in shape--a necessary feature for use in meteorological dispersion models.

The Universal Transverse Mercator Projection is based upon the metric system. Each north-south and east-west grid line, as illustrated in Figure 4, is identified by a coordinate number expressed in meters. Each point source and grid is identified by the horizontal and vertical coordinates of their geographical center to the nearest 100 meters.

As shown in Figure 4, the Study Area was divided into 100 grids of three different sizes--25, 100, and 400 square kilometers. Grid zones of different sizes are used to limit the number of grid zones and yet allow a satisfactory definition of the geographical gradation of emissions. The majority of the emissions is usually concentrated in the populated and industrialized portions of a Study Area. Smaller grids are placed over these areas in order to reflect abrupt changes in emissions within short

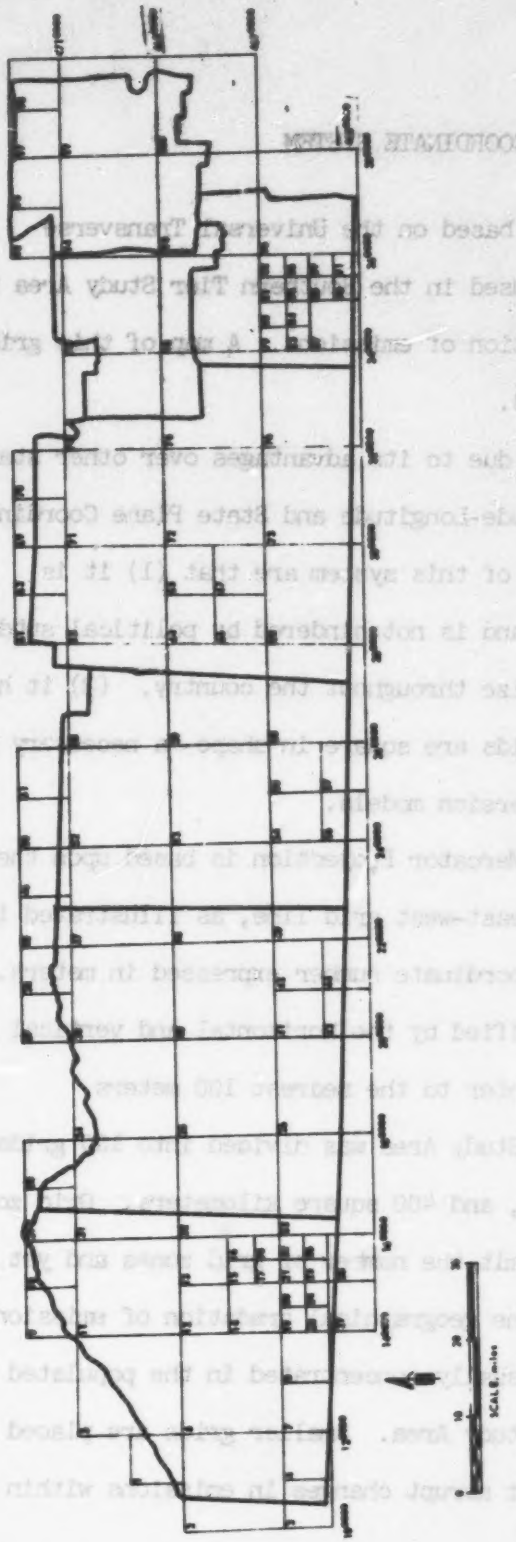

Figure 4. Grid coordinate system for study area.

distances. The use of grid zones smaller than 25 square kilometers is not warranted because of the inherent inaccuracies in the data. Since only a small percentage of the total emissions occur in rural areas, larger grid zones are normally used to show the distribution of emissions in these lightly populated portions of a Study Area.

EMISSIONS BY CATEGORY

For the purposes of compiling the basic data and emission estimates, the air pollutant sources were classified into the following five categories:

1. Stationary fuel combustion
2. Transportation
3. Solid waste disposal
4. Industrial processes
5. Evaporative losses

Each of these categories is considered individually in this section where data sources are given and methods of calculation discussed.

STATIONARY FUEL COMBUSTION

The stationary fuel combustion category is concerned with any fixed source which burns fuels for either space heating or process heating. The four primary sources in this category are industrial facilities, steam-electric plants, residential housing, and commercial and institutional establishments. In the Study Area, coal, distillate oil and residual oil were all used. Tables 5 through Table 8 present a summary of the fuels consumed in the Study Area, and Table 9 presents an average chemical analysis of these fuels.

Steam-Electric Utility

METHODOLOGY: Data on the four power plants in the area was acquired from the Niagara Mohawk Power Corporation, Jamestown Board of Public

TABLE 5 ANNUAL CONSUMPTION OF NATURAL GAS IN THE STUDY AREA, 1970

(Million Cubic Feet)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Allegany	—	530	2,740	750	4,020
Cattaraugus	—	560	4,510	630	5,700
Chautaugua	—	3,400	7,710	2,650	13,760
Chemung	—	3,930	5,360	2,230	11,520
Schuyler	—	100	510	400	1,010
Steuben	—	2,730	4,780	1,550	9,060
Tompkins	—	530	3,160	2,100	5,790
GRAND TOTAL	—	11,780	28,770	10,310	50,860

TABLE 6 ANNUAL CONSUMPTION OF COAL IN THE STUDY AREA, 1970

(Tons)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Allegany	—	—	3,760	21,000	24,760
Cattaraugus	—	3,000	9,830	16,460	29,290
Chautauqua	1,331,000	1,200	12,760	71,380	416,340
Chemung	—	538,500	10,950	39,460	588,910
Schuyler	—	6,000	4,200	2,000	12,200
Steuben	335,900	34,530	12,250	19,720	402,400
Tompkins	843,600	5,770	8,720	36,200	849,290
GRAND TOTAL	2,510,500	589,000	62,470	206,220	3,368,190

NA - Information not available or not reported.

TABLE 7 ANNUAL CONSUMPTION OF DISTILLATE FUEL OIL IN THE STUDY AREA, 1970

(1,000 Gallons)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Allegany	—	1,460	3,380	8,240	13,080
Cattaraugus	—	2,630	8,870	5,720	17,220
Chautauqua	—	8,320	9,600	27,950	45,870
Chemung	—	2,240	7,220	2,270	11,730
Schuyler	—	1,000	3,520	1,000	5,520
Steuben	—	8,080	11,750	10,100	29,930
Tompkins	—	2,400	10,270	12,000	24,670
GRAND TOTAL	—	26,130	54,610	67,280	148,020

TABLE 8 ANNUAL CONSUMPTION OF RESIDUAL FUEL OIL IN THE STUDY AREA, 1970

(1,000 Gallons)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Allegany	—	3,420	—	7,190	10,610
Cattaraugus	—	6,130	—	3,700	9,830
Chautauqua	—	19,410	—	23,470	42,880
Chemung	—	5,610	—	2,520	8,130
Schuyler	—	1,000	—	1,000	2,000
Steuben	—	19,210	—	12,070	31,280
Tompkins	—	5,660	—	12,600	18,260
GRAND TOTAL	—	60,440	—	62,550	122,990

TABLE 9 AVERAGE CHEMICAL ANALYSIS OF FUELS CONSUMED IN THE STUDY AREA, 1970

Type Fuel	Type Source	% by weight Ash Content	% by Weight Sulfur Content
Coal	Steam-Electric	15.0	2.0
	Industrial	10.0	1.5
	Domestic-Commercial	6.0	0.9
Residual Fuel Oil	Steam-Electric	NU	NU
	Industrial	N	1.5
	Domestic-Commercial	NU	NU
Distillate Fuel Oil	Steam-Electric	NU	NU
	Industrial	N	.5
	Domestic-Commercial	N	.25

N = Negligible

NU = Fuel not used by this type source

Utilities, and New York State Gas and Electric, Corporation, and compared to figures presented by the National Coal Association.[5] The data included the annual fuel consumption for 1970, type and efficiency of control equipment, sulfur and ash content of the fuel and the type of furnace.

RESULTS: All four of the power plants in the area use pulverized coal-fired boilers which range in size from 300 million BTU/hr - 1,400 million BTU/hr. Approximately 2.5 million tons of coal were consumed in these boilers in 1970. Of this 2.5 million tons, .5 million was consumed in boilers with mechanical control devices for particulates. The remaining 2.0 million tons were controlled by either a mechanical (multiple cyclone) collector or an electrostatic precipitator. The efficiencies of these controls ranged from a low of 80 percent with an overloaded mechanical collector to 95 percent with electrostatic precipitators. The average weighted efficiency of the 2.5 million tons of coal which was controlled was 92 percent.

Air pollutant emissions from fuel combustion at these plants as well as from all other fuel combustion sources are summarized in Table 10. The steam-electric plants were the largest sources of sulfur oxides, particulates and nitrogen oxides in the Study Area. Over 54 percent of the total sulfur oxides from stationary fuel combustion, 64 percent of the particulates, and 63 perdent of the nitrogen oxides were attributed to these four plants.

Industrial

METHODOLOGY: Since in a rapid survey of industrial sources it is impossible to contact every plant, other techniques must be used to determine the contribution of industrial fuel combustion sources. In

order to do this, the total quantities of the various fuels used are determined and the amounts used by the largest industries are found. The remaining sources are considered collectively as area sources and their fuel use is based on the difference between the total and the amount consumed by the largest sources.

The total quantities of residual and distillate fuel oil consumed by industrial were estimated using Bureau of Mines' Mineral Industry surveys. These were compared to totals provided by the majority of the acknowledged agencies. Natural gas numbers were obtained from each of the local suppliers who provided the breakdown by user category. Total coal consumption by industrial sources was based solely on questionnaire data or personal contacts made by the local agencies.

The quantities of all fuels used by individual industries was found and then subtracted from the totals to determine area sources fuel use.

It should be noted that fuel combustion by industries include both fuel used for space heating, and fuel used for process heating. A national average was used to separate process heating from space heating.

RESULTS: Coal, distillate oil, residual oil and natural gas were all used by industrial sources in the Study Area. The consumption of these fuels is summarized in Tables 5 through 8.

Table 10 shows the relative contribution of each fuel to the total emissions from stationary fuel combustion. Industrial sources account for 27 percent of total sulfur oxide emissions from stationary fuel combustion, 22 percent of particulates, 40 percent of carbon monoxide, 47 percent of hydrocarbons, and 17 percent of nitrogen oxides.

Residential

METHODOLOGY: Natural gas, distillate fuel oil and coal were the primary fuels used for residential home heating. There were homes heated

by other fuels, but they represent a small percentage of the total. Data on the amount of natural gas used for domestic heating was supplied by the local power companies and compared with the rapid survey technique of estimating the fuel used for home heating.[6] Distillate oil and coal consumption data were estimated based on data supplied by local agencies and on the rapid survey technique.

RESULTS: Table 11 gives an estimate of the number of homes that use each type fuel in the Study Area. The overall percentage of the number of homes that use each type fuel consists of natural gas being used in 75 percent of the dwelling units, fuel oil 21 percent and coal 4 percent.

Emissions resulting from residential fuel combustion are relatively low for all pollutants. However, since coal is not burned efficiently in homes, carbon monoxide and hydrocarbons are higher than might be expected. The contribution to total emissions from stationary fuel combustion by domestic heating was less than 1 percent for any pollutant except for carbon monoxide (28%) and hydrocarbons (19%).

Commercial-Institutional

METHODOLOGY: Commercial and institutional establishments in the Study Area used all four of the previously mentioned fuels—distillate and residual oil, natural gas and coal. Data on the total amounts of these fuels used in the area as well as the consumption at individual establishments are supplied by power companies, fuel associations and the local agencies.

RESULTS: The use of coal and fuel oil at commercial and institutional establishments was by far the most significant source of emissions from

TABLE 10 AIR POLLUTANT EMISSIONS FROM THE COMBUSTION OF FUELS IN STATIONARY SOURCES IN THE STUDY AREA, 1970 (Tons/Year)

Fuel User Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Coal					
Industrial	27,690	6,770	2,890	900	1,850
Steam-Electric	89,600	22,380	1,250	400	22,570
Residential	2,750	720	1,560	300	150
Commercial and Institutional	9,800	2,060	1,030	300	600
Subtotal	129,840	31,930	6,730	1,900	25,170
Fuel Oil					
Industrial	16,330	900	N	130	3,100
Steam-Electric	—	—	—	—	—
Residential	1,120	300	150	80	350
Commercial and Institutional	17,620	1,200	N	190	4,700
Subtotal	35,070	2,400	150	400	8,150
Gas					
Industrial	N	110	N	240	1,030
Steam-Electric	—	—	—	—	—
Residential	10	270	300	100	1,080
Commercial and Institutional	N	100	100	50	390
Subtotal	10	480	400	390	2,500
GRAND TOTAL[a]	164,920	34,810	7,280	2,690	35,820

N = Negligible

A = Totals have been rounded.

TABLE 11 SUMMARY OF DOMESTIC HEATING BY NUMBER OF DWELLING UNITS IN THE STUDY AREA, 1970

Jurisdiction	Coal	Fuel Oil	Natural Gas
Allegany	370	1,950	10,260
Cattaraugus	1,010	5,320	17,520
Chautauqua	1,700	7,470	38,890
Chemung	1,310	5,040	24,230
Schuyler	440	2,140	2,010
Steuben	1,390	7,760	20,460
Tompkins	1,010	6,940	13,820
TOTAL	7,230	36,620	127,190
OVERALL PERCENTAGE	4%	21%	75%

this category. These fuels contributed largely to sulfur oxides (17%) and nitrogen oxides (16%).

TRANSPORTATION

Three types of transportation sources of air pollution are considered in this survey—motor vehicles, aircraft, and railroads. Motor vehicles, which are by far the most significant source in this category, are further subdivided according to type of fuel—gasoline or diesel.

Motor Vehicles

About 8 million miles per day were traveled by motor vehicles in 1970 in the Study Area. In the process, 180 million gallons of gasoline and 11 million gallons of diesel fuel were consumed for highway purposes. Table 12 shows the miles of travel for gasoline and diesel vehicles for each county in the Study Area.

Vehicle-miles data for essentially all of the roads in the study area were supplied by the New York Appalachian resource transportation studies. These figures were compared with gasoline consumption figures and a good correlation was obtained.

The contribution to the total motor vehicle pollution by diesel-powered vehicles was determined by assuming that approximately six percent of the total fuel consumed was by diesel-powered vehicles. These emissions were apportioned on a grid basis by assuming they were proportional to gasoline emissions.

TABLE 12 VEHICLE MILES OF TRAVEL FOR MOTOR VEHICLES IN THE STUDY AREA, 1970 (Vehicle Miles/Day)

Jurisdiction	Gasoline Vehicle Miles	Diesel Vehicle Miles	Total
Allegany	581,000	11,200	592,200
Cattaraugus	1,069,000	22,400	1,091,400
Chautauqua	2,046,000	43,000	2,089,000
Chemung	1,312,000	27,600	1,339,600
Schuyler	234,000	4,900	238,900
Steuben	1,459,000	30,600	1,489,600
Tompkins	1,006,000	22,300	1,028,300
GRAND TOTAL	7,707,000	162,000	7,869,000

Emissions from motor vehicles are a function of the speed at which the vehicle travels. Average speeds of 10-20 mph were assumed for downtown areas, 20-30 mph for the residential areas, and 30-45 mph for the rural areas to calculate vehicle emissions.

From all transportation sources, motor vehicles accounted for 83 percent of the sulfur oxides, 85 percent of the particulates, 99 percent of the carbon monoxide, 97 percent of the hydrocarbons, and 98 percent of the nitrogen oxides. Gasoline powered motor vehicles contributed a greater percent of all pollutants than diesel powered motor vehicles. Emissions from transportation sources are summarized in Table 13.

Aircraft

Chemung County airport was the only airport in the study area that was listed in the Federal Aviation Administration Aircraft Activity manual.

The air pollutant emissions from aircraft include all phases of operation (taxi, take-off, climb out, approach and landing) that take place below the arbitrarily chosen altitude of 3,500 feet. Emissions at cruise altitude (above 3,500 feet) are not of concern in an emission inventory. From all transportation sources, aircraft accounted for 10 percent of the particulates, 1 percent of the carbon monoxide, 2 percent of the hydrocarbons and 1 percent of the nitrogen oxides.

Railroads

Railroad operations (mainly locomotive) consume about 5 million gallons of diesel fuel per year within the Study Area. This quantity

TABLE 13 SUMMARY OF AIR POLLUTANT EMISSIONS FROM TRANSPORTATION SOURCES, 1970 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Motor Vehicles					
Gasoline	835	1,100	184,560	26,000*	11,700
Diesel	260	190	1,900	410	1,985
Subtotal	1,095	1,240	186,460	26,410	13,685
Aircraft					
Jet	20	90	200	350	60
Piston	40	35	1,900	230	N
Turboprop	N	25	10	10	20
Subtotal	60	150	2,110	590	80
Railroads	165	70	180	130	185
GRAND TOTAL	1,320	1,460	188,750	27,130	13,950

* Includes automobile evaporative losses

is about 55 percent less than the amount of diesel fuel consumed by motor vehicles. The majority of this fuel is consumed during switching operations. Diesel fuel consumption data was obtained from Bureau of Mines' Mineral Industry Studies.

Railroad operations contribute about 12 percent of the sulfur oxides and 5 percent of the particulates from all transportation sources. They account for less than 3 percent of the emissions for any other pollutant.

SOLID WASTE DISPOSAL

Approximately .9 million tons of refuse was generated during 1970 within the Study Area. Table 14 presents a solid waste balance for the Southern Tier Study Area, showing the various methods of disposal and the quantities disposed of by each method. There were open burning dumps in Allegany, Cattaraugus, and Chautaugua counties. In all of the counties it was assumed that backyard burning and incineration took place in rural areas. There were no municipal incinerators operating in the study area by the end of 1970, therefore the remainder of solid waste was disposed of largely in non-burning dumps and landfills.

For the entire Study Area 13 percent of the refuse was disposed of by on-site incinerators, 61 percent by landfills or non-burning dumps, 4 percent by open burning dumps and 22 percent by backyard burning. Refuse data for all of the New York counties was supplied by the State Department of Solid Waste.

Incineration

In the Study Area there was only one industrial incinerator used to dispose of solid waste. This was a relatively small incinerator

located in Chemung County. The amount of refuse disposed of by on-site incineration was assumed to be approximately 13 percent of the generated refuse in each county. In all counties the 108,000 tons of refuse burned by on-site incinerators was treated as an area source and apportioned to rural grids by population. Only the one industrial incinerator was classified as a point source.

The incineration of refuse contributed 15 percent of the total sulfur oxide emissions from solid waste disposal, 18 percent of the particulates, negligible carbon monoxide, 15 percent of the nitrogen oxides and 3 percent of the hydrocarbons.

Open Burning

The two major categories of open burning are open burning dumps and on-site open burning. On-site open burning was the largest contributor to the air pollution from solid waste disposal. There were approximately 20 open burning dumps in the Study Area, none of which were classified as point sources. The open burning of approximately 188,000 tons of waste in backyards was a significant factor in solid waste disposal. This 108,000 tons was treated as area source emissions and apportioned onto grids by population.

The open burning of refuse contributed 85 percent of total sulfur oxide emissions from solid waste disposal, 72 percent of the particulates, 100 percent of the carbon monoxide, 85 percent of the nitrogen oxides and 97 percent of the hydrocarbons.

TABLE 14 SOLID WASTE BALANCE FOR STUDY AREA, 1970 (Tons/Year)

Political Jurisdiction	Total Refuse Generated	Incineration		Landfills or Non Burning Dumps	Open Burning	
		Municipal	On-site		Dumps	On-Site
Allegany	68,000	—	8,500	39,500	1,400	18,600
Cattaraugus	120,000	—	15,000	76,000	15,000	14,000
Chautuaqua	223,700	—	28,000	135,700	20,000	40,000
Chemung	158,000	—	20,000	106,400	—	31,600
Schuyler	227,000	—	2,900	12,900	—	6,900
Steuben	148,700	—	18,600	89,100	—	41,000
Tompkins	120,000	—	15,000	70,500	—	34,500
TOTALS	861,100	—	108,000	530,100	35,000	188,000

TABLE 15 AIR POLLUTANT EMISSIONS FROM SOLID WASTE DISPOSAL, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Incineration					
Municipal	—	—	—	—	—
On-Site	20	380	10	115	120
Subtotal	20	380	10	115	120
Open Burning					
On-Site	90	1,490	7,930	2,800	560
Dump	20	290	1,540	535	110
Subtotal	110	1,780	9,470	3,335	670
GRAND TOTAL	130	2,160	9,480	3,450	790

N = Negligible

INDUSTRIAL PROCESSES

The Study Area is characterized by the large number of furniture mills. The operations that take place at these mills are of concern in an emission inventory mainly because of the particulate emissions. From an air pollution standpoint the mineral products industry was by far the most significant industrial process sources. In the mineral products industry the largest sources were concrete batch plants and sand and gravel operations. In the food and agricultural industry the largest sources were 2 fertilizer plants and one tanning operation. The only other large industrial process sources were grey iron foundries. Other industries that generated air pollutant emissions from their processes included a steel fabrication plant, a railroad engine repair shop, glass manufacturing, and a salt processing operation. Table 16 presents a summary of the emissions from the various industrial processes.

The concrete batching plants in the Study Area accounted for 29 percent of the particulate emissions. An additional 26 percent was attributed to sand and gravel operations that supply the concrete and asphalt plants.

The largest portion (96%) of carbon monoxide emissions came from uncontrolled grey iron foundries. Glass melting contributed over 55 percent of the nitrogen oxide emissions. The remaining emissions from industrial processes are summarized in Table 16.

TABLE 16 SUMMARY OF AIR POLLUTANT EMISSIONS FROM INDUSTRIAL PROCESSES, 1970 (Tons/Year)

Type Industry	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Mineral Products					
Glass Manufacturing	100	360	—	—	150
Rock-sand processing	80	1,310	—	—	—
Concrete batching	—	1,460	—	—	—
Salt processing	—	250	—	—	—
Subtotal	190	3,380	—	—	150
Metallurgical					
Gray Iron Foundry	10	330	9,750	—	—
Steel Fabrication	—	30	320	—	—
Furniture	—	700	—	—	—
Railroad Engine Repair	100	170	110	80	110
Food and Agricultural					
Tanning	20	50	—	—	10
Fertilizer	—	390	—	—	—
Subtotal	20	440	—	—	10
GRAND TOTALS	310	5,050	10,180	80	270

EVAPORATIVE LOSSES

Three source categories were considered for evaporative losses—automobiles, gasoline storage and handling, and the consumption of solvents. The hydrocarbon emissions from all sources by evaporative losses are shown in Table 17.

Automobiles

Automobile evaporation losses include gas tank and carburetor evaporation and engine crankcase blowby. Since 1963, most new automobiles were equipped with positive crankcase ventilation (PCV) valves that reduce hydrocarbon emissions from the crankcase by about 90 percent. Due to a lag time in the automobile replacement rate, it was assumed that 20 percent of the automobiles were not equipped with PCV valves.

The hydrocarbon emissions from automobiles were calculated from vehicle-mile data and were apportioned onto grids using the same methods as for motor vehicles discussed earlier. Evaporative losses from automobiles accounted for 64 percent of the total hydrocarbon emissions from evaporative losses in the Study Area.

Gasoline Storage and Handling

There are four major points (excluding evaporation from the motor vehicle) of hydrocarbon emissions in the storage and handling of gasoline. There are:

1. Breathing and filling losses from storage tanks
2. Filling losses from loading tank conveyances
3. Filling losses from loading underground storage tanks at service stations.

4. Spillage and filling losses in filling automobile gas tanks at service stations.

Approximately 89 million gallons of gasoline and diesel fuel were stored in the Study Area in 1970. The evaporative losses from this storage and the subsequent handling accounted for 13 percent of the total evaporative losses.

Consumption of Solvents

This category included the consumption of solvents at dry cleaning plants, industrial solvent usage and the miscellaneous use of solvents by small commercial establishments and domestic units. Organic solvents emitted from these operations were determined by assuming an emission rate ranging from 2 to 5 lb/capita/year for any cleaning plants. Industrial solvent usage was obtained from questionnaire data supplied by the state air pollution office. The consumption of solvents by these three categories accounted for 23 percent of the hydrocarbon emissions from evaporative losses.

TABLE 17 HYDROCARBON EMISSIONS FROM EVAPORATIVE LOSS SOURCES IN THE STUDY AREA, 1970 (Tons/Year)

Type of Source	Hydrocarbons
Gasoline Storage and Handling	2,430
Automobiles	11,570
Solvent Consumption	
Industrial	3,220
Dry Cleaning	980
GRAND TOTAL	18,200

EMISSIONS BY JURISDICTION

The previous section presented the air pollutant emissions by source category. In order to show the contribution of each county to the pollution in the entire Study Area, their emissions are summarized in Tables 18 through 24.

As can be expected, since power plants play such a big part in the overall air pollution in the Study Area, the counties with power plants seem to be the most significant from a sulfur oxide particulate and nitrogen oxide standpoint.

TABLE 18 SUMMARY OF AIR POLLUTANT EMISSIONS IN ALLEGANY COUNTY, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	80	90	11,590	970	1,030
Other	10	10	10	10	10
Subtotal	90	100	11,600	980	1,040
Stationary Fuel Combustion					
Industry	920	60	N	20	220
Steam-Electric	—	—	—	—	—
Residential	250	80	130	30	130
Commercial and Institutional	2,030	360	110	60	650
Subtotal	4,200	500	240	110	1,000
Refuse Disposal					
Incineration	N	30	—	10	10
Open Burning	10	160	850	300	60
Subtotal	10	190	850	310	70
Industrial Processes	10	420	3,400	—	—
Evaporative Losses	—	—	—	1,120	—
GRAND TOTAL[a]	4,310	1,210	16,090	2,520	2,110

N = Negligible

a = Totals have been rounded.

TABLE 19 SUMMARY OF AIR POLLUTANT EMISSIONS IN CATTARAUGUS COUNTY, 1970
(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Road Vehicles	150	170	24,330	1,970	1,900
Other	20	10	30	20	30
Subtotal	170	180	24,360	1,990	1,930
Stationary Fuel Combustion					
Industry	1,740	320	N	30	390
Steam-Electric	—	—	—	—	—
Residential	660	190	310	80	250
Commercial and Institutional	1,860	260	90	40	410
Subtotal	4,260	770	400	150	1,050
Refuse Disposal					
Incineration	N	50	—	15	20
Open Burning	20	230	1,230	435	90
Subtotal	20	280	1,230	450	110
Industrial Processes	20	740	—	—	10
Evaporative Losses	—	—	—	2,640	—
GRAND TOTAL[a]	4,470	1,970	25,990	5,230	3,100

N = Negligible

a = Totals have been rounded.

TABLE 20 SUMMARY OF AIR POLLUTANT EMISSIONS IN CHAUTAUQUA COUNTY, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	290	330	52,270	4,090	3,630
Other	40	20	50	30	50
Subtotal	330	350	52,320	4,120	3,680
Stationary Fuel Combustion					
Industry	5,290	400	N	110	1,310
Steam-Electric	41,890	12,080	670	200	11,980
Residential	820	240	420	110	380
Commercial and Institutional	10,050	1,220	390	200	2,160
Subtotal	58,050	13,940	1,480	620	15,830
Refuse Disposal					
Incineration	10	100	—	30	30
Open Burning	30	480	2,550	900	180
Subtotal	40	580	2,550	930	210
Industrial Processes	—	2,410	—	—	—
Evaporative Losses	—	—	—	6,370	—
GRAND TOTAL[a]	58,420	17,280	56,350	12,040	19,720

N = Negligible

a = Totals have been rounded.

TABLE 21 SUMMARY OF AIR POLLUTANT EMISSIONS IN CHEMUNG COUNTY, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	190	210	37,240	2,860	2,330
Other	90	160	2,140	610	110
Subtotal	280	370	39,380	3,470	2,440
Stationary Fuel Combustion					
Industry	27,090	5,500	2,690	900	2,240
Steam-Electric	—	—	—	—	—
Residential	680	200	350	90	270
Commercial and Institutional	2,580	460	220	80	380
Subtotal	30,350	6,160	3,260	1,070	2,890
Refuse Disposal					
Incineration	10	80	10	30	20
Open Burning	10	250	1,340	470	100
Subtotal	20	330	1,350	500	120
Industrial Processes	N	660	6,670	—	—
Evaporative Losses	—	—	—	2,600	—
GRAND TOTAL	30,650	7,520	50,660	7,640	5,450

a = Totals have been rounded.

TABLE 22 SUMMARY OF AIR POLLUTANT EMISSIONS IN SCHUYLER COUNTY, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	35	40	4,610	390	415
Other	5	N	N	N	5
Subtotal	40	40	4,610	390	420
Stationary Fuel Combustion					
Industry	390	490	N	10	130
Steam-Electric	—	—	—	—	—
Residential	260	60	120	30	50
Commercial and Institutional	380	40	20	10	90
Subtotal	1,030	590	140	50	270
Refuse Disposal					
Incineration	N	10	N	N	N
Open Burning	N	50	290	100	20
Subtotal	N	60	290	100	20
Industrial Processes	—	250	—	—	—
Evaporative Losses	—	—	—	640	—
GRAND TOTAL[a]	1,070	940	5,040	1,180	710

N = Negligible

a = Totals have been rounded

TABLE 23 SUMMARY OF AIR POLLUTANT EMISSIONS IN STEUBEN COUNTY, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	210	240	32,440	2,640	2,590
Other	40	10	40	30	40
Subtotal	250	250	32,480	2,670	2,630
Stationary Fuel Combustion					
Industry	6,770	850	160	140	1,350
Steam-Electric	10,850	7,798	170	58	3,020
Residential	610	290	380	100	280
Commercial and Institutional	4,290	430	120	70	920
Subtotal	22,520	9,360	830	360	5,570
Refuse Disposal					
Incineration	N	60	N	20	20
Open Burning	—	20	330	1,740	610	120
Subtotal	20	390	1,740	—	630	140
Industrial Processes	200	570	100	80	260
Evaporative Losses	—	—	—	2,890	—
GRAND TOTAL[a]	22,990	10,570	35,150	6,630	8,600

N = Negligible

a = Totals have been rounded.

TABLE 24 SUMMARY OF AIR POLLUTANT EMISSIONS IN TOMPKINS COUNTY, 1970

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	140	160	23,980	1,920	1,790
Other	20	10	20	20	20
Subtotal	160	170	24,000	1,940	1,810
Stationary Fuel Combustion					
Industry	1,800	150	30	30	350
Steam-Electric	36,870	2,510	420	130	7,590
Residential	600	210	280	70	200
Commercial and Institutional	5,240	620	200	100	1,070
Subtotal	44,510	3,490	930	330	9,210
Refuse Disposal					
Incineration	N	50	N	10	20
Open Burning	20	280	1,470	520	100
Subtotal	20	330	1,470	530	120
Industrial Processes	80	—	—	—	—
Evaporative Losses	—	—	—	1,940	—
GRAND TOTAL[a]	44,770	3,990	26,400	4,740	11,140

N = Negligible

a = Totals have been rounded.

EMISSIONS BY GRID

For the purpose of defining the geographical variation of air pollutant emissions in the Study Area, the resulting emissions were apportioned on the grid coordinate system. The emissions were divided into two source groups—point and area sources. Fifty-two point sources are identified individually with respect to location and emissions. The majority of these point sources emitted more than .1 tons per average annual day of any pollutant.

CONTRIBUTIONS OF POINT AND AREA SOURCES

Figure 5 shows the location of all point sources in the area. Collectively the fifty-two point sources account for 54 percent of the sulfur oxides, 63 percent of the particulates, 45 percent of the nitrogen oxides, and only 5 percent of the carbon monoxide and 2 percent of the hydrocarbons. The percentage contribution to carbon monoxide emissions is low because motor vehicles, which are area sources, contribute 87 percent of the total carbon monoxide emissions. Similarly, the contribution to total hydrocarbon emissions is low since two groups of area sources, motor vehicles and evaporative losses are the major sources. Table 25 presents the emissions of point sources. Each source is identified by source category, grid number and horizontal and vertical coordinates. The emissions of sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides are shown for an average annual day, average winter day (December,

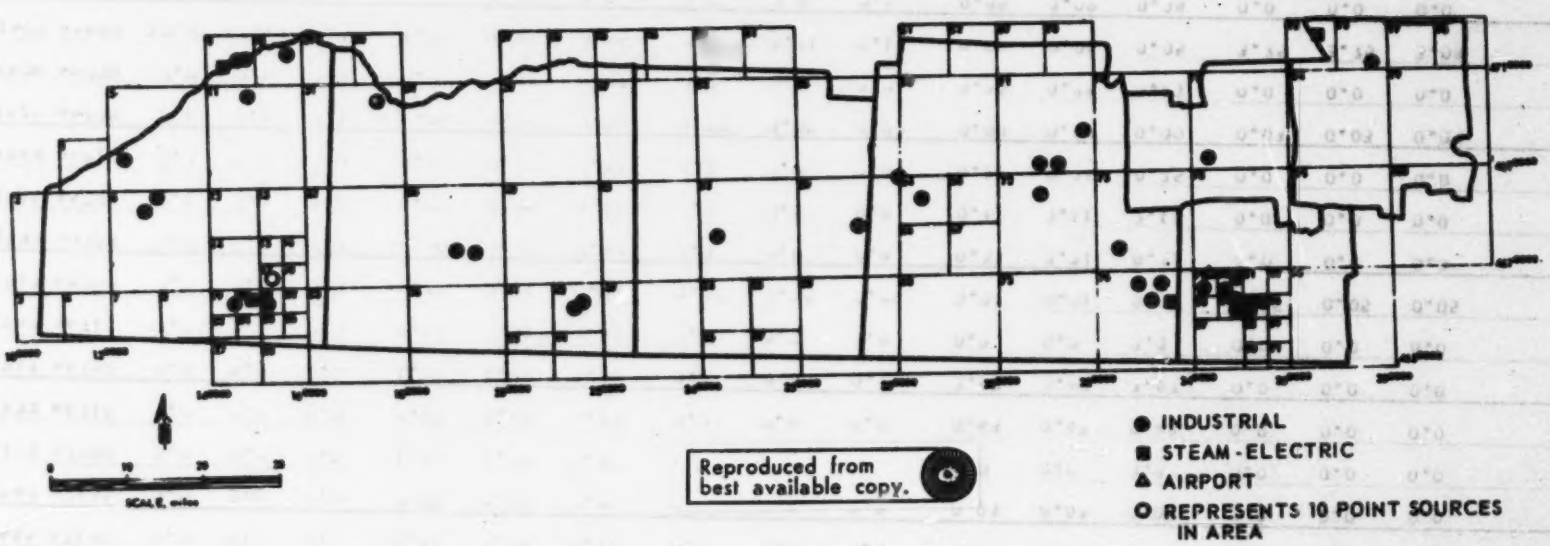

Figure 5. Point scource locations in study area.

TABLE 25 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES

TONS/YEAR

ID	CO	HC	YC	SOX			PART			CO			HC			NOX		
				S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
2	5	1217	46950	0.0	0.0	0.0	0.10	0.13	0.14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	6	1300	46938	0.0	0.0	0.0	0.39	0.39	0.39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	5	1280	46970	0.0	0.0	0.0	0.10	0.10	0.10	0.0	0.0	0.0	0.27	0.27	0.27	0.0	0.0	0.0
1	9	1425	47130	122.2	122.2	100.4	39.22	39.22	32.23	2.01	2.01	1.65	0.60	0.60	0.50	36.18	36.18	29.74
2	9	1438	47130	0.0	0.0	0.0	0.24	0.24	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	9	1455	47130	0.0	0.0	0.0	0.26	0.26	0.26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	10	1540	47165	0.0	0.0	0.0	0.25	0.25	0.25	0.0	0.0	0.0	0.03	0.03	0.03	0.0	0.0	0.0
2	11	1455	47090	0.0	0.0	0.0	1.75	1.75	1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	17	1530	46712	0.0	0.0	0.0	0.20	0.20	0.20	0.0	0.0	0.0	0.43	0.43	0.43	0.0	0.0	0.0
2	17	1518	46702	0.0	0.0	0.0	1.20	1.20	1.20	0.0	0.0	0.0	3.67	3.67	3.67	0.0	0.0	0.0
2	17	1542	46712	0.0	0.0	0.0	0.51	0.51	0.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	17	1513	46740	0.0	0.0	0.0	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.05	0.05	0.05
2	17	1530	45709	0.0	0.0	0.0	0.20	0.20	0.20	0.0	0.0	0.0	0.31	0.31	0.31	0.0	0.0	0.0
2	17	1511	46702	0.0	0.0	0.0	0.08	0.08	0.08	0.0	0.0	0.0	0.11	0.11	0.11	0.0	0.0	0.0
2	17	1549	46712	0.0	0.0	0.0	0.20	0.20	0.20	0.0	0.0	0.0	0.25	0.25	0.25	0.0	0.0	0.0
2	17	1520	46709	0.1	0.1	0.1	0.26	0.26	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03
2	17	1506	46700	0.0	0.0	0.0	0.02	0.02	0.02	0.0	0.0	0.0	0.23	0.23	0.23	0.0	0.0	0.0
1	20	1405	44485	17.4	17.4	14.3	1.05	1.05	0.85	0.21	0.21	0.17	0.06	0.06	0.05	3.75	3.75	3.08
2	20	1451	44466	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08	0.08	0.08	0.0	0.0	0.0
2	21	1501	44433	0.0	0.0	0.0	0.13	0.13	0.13	0.0	0.0	0.0	0.08	0.08	0.08	0.0	0.0	0.0
2	21	1505	44439	0.0	0.0	0.0	0.03	0.03	0.03	0.0	0.0	0.0	0.10	0.10	0.10	0.0	0.0	0.0
2	21	1505	44455	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08	0.08	0.08	0.0	0.0	0.0
2	21	1505	44443	0.0	0.0	0.0	0.07	0.07	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	31	1760	47080	0.0	0.0	0.0	0.13	0.13	0.13	0.0	0.0	0.0	0.55	0.55	0.55	0.02	0.02	0.02

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TABLE 25 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES
(Continued)
TONS/YEAR

2	35	1920	46750	0.0	0.0	0.0	0.43	0.43	0.43	0.0	0.0	0.0	0.83	0.83	0.83	0.0	0.0	0.0
2	35	1950	46748	0.0	0.0	0.0	0.22	0.22	0.22	0.0	0.0	0.0	0.23	0.23	0.23	0.0	0.0	0.0
2	42	2156	44650	0.2	0.2	0.2	1.10	1.10	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.07
2	42	2152	44648	0.0	0.0	0.0	0.74	0.74	0.74	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	53	2465	46780	0.0	0.0	0.0	0.06	0.06	0.06	9.32	9.32	9.32	0.0	0.0	0.0	0.0	0.0	0.0
2	59	2730	46830	0.0	0.0	0.0	1.09	1.09	1.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	59	2800	46800	0.0	0.0	0.0	0.03	0.03	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	64	2820	46870	0.3	0.3	0.3	0.45	0.45	0.45	0.29	0.29	0.29	0.20	0.20	0.20	0.31	0.31	0.31
2	71	3080	46915	0.0	0.0	0.0	0.13	0.13	0.13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	71	3170	46970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06	0.06	0.06	0.0	0.0	0.0
2	71	3105	46917	0.3	0.3	0.3	0.66	0.66	0.66	0.00	0.00	0.00	0.15	0.15	0.15	0.09	0.09	0.09
2	72	3065	46880	0.0	0.0	0.0	0.28	0.28	0.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	75	3235	46714	0.0	0.0	0.0	0.04	0.04	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	76	3370	46650	36.2	36.2	29.7	25.96	25.96	21.34	0.56	0.56	0.46	0.17	0.17	0.14	10.08	10.08	8.28
2	76	3300	46678	0.3	0.3	0.3	0.38	0.38	0.38	0.0	0.0	0.0	0.0	0.0	0.0	0.41	0.41	0.41
2	76	3325	46660	0.0	0.0	0.0	0.04	0.04	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	76	3270	46690	0.0	0.0	0.0	0.21	0.21	0.21	0.0	0.0	0.0	0.07	0.07	0.07	0.0	0.0	0.0
2	77	3445	46935	0.3	0.3	0.3	1.94	1.94	1.94	0.01	0.01	0.01	0.00	0.00	0.00	0.14	0.14	0.14
2	79	3430	46677	0.0	0.0	0.0	0.07	0.07	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	79	3435	46690	0.2	0.2	0.2	0.40	0.40	0.40	5.78	5.78	5.78	1.63	1.63	1.63	0.22	0.22	0.22
2	80	3489	46661	0.0	0.0	0.0	0.08	0.08	0.08	0.89	0.89	0.89	0.09	0.09	0.09	0.01	0.01	0.01
2	80	3497	46675	0.0	0.0	0.0	0.35	0.35	0.35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	84	3494	46635	0.0	0.0	0.0	0.14	0.14	0.14	17.40	17.40	17.40	0.0	0.0	0.0	0.0	0.0	0.0
2	84	3495	46643	0.0	0.0	0.0	0.61	0.61	0.61	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	85	3507	46606	0.0	0.0	0.0	0.12	0.12	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	85	3520	46616	0.0	0.0	0.0	0.45	0.45	0.45	0.0	0.0	0.0	0.11	0.11	0.11	0.0	0.0	0.0
1	92	3660	47175	123.9	123.9	101.0	8.37	8.37	6.82	1.41	1.41	1.16	0.42	0.42	0.35	25.31	25.31	20.80
2	93	3765	47103	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

January, February) and average summer day (June, July, August). The appendix presents the method of calculating these three averages.

Area sources are sources of emissions that are significant by themselves, but as a group may emit a large portion of the areas total pollution. Examples of area sources are motor vehicles, residences, light commercial and industrial establishments and backyard burning. The emissions from area sources have been added to that for point sources to obtain total emissions from all sources by grid. as shown in Table 26. The emissions from all sources are also shown for an annual average, winter and summer day.

EMISSION DENSITIES

In order to provide a visual representation of the emissions of pollutants by grids, emission density maps have been prepared. Emission densities were obtained by summing the annual area and point source emissions for each grid and dividing this total by the land area of the grid. Figures 6 through 10 show the variation in emission densities for the respective grids throughout the Study Area. As expected the emissions generally follow the pattern and degree of urbanization. Emission densities for carbon monoxide and hydrocarbons are higher in the grids with the higher populations and corresponding higher vehicular activity. Sulfur oxides, particulates and nitrogen oxide emission densities are highest in the grids where power plants are located. Particulate emissions tend to follow the general pattern of the location of industrial and other sources as shown in Figure 5.

TABLE 26 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES

TONS/YEAR

		SOX			PART			CO			HC			NOX		
GRID	AREA	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
1	38.6	0.0	0.8	0.4	0.1	0.2	0.1	5.4	4.5	4.9	1.0	0.9	1.0	0.6	0.7	0.6
2	154.4	0.0	3.0	1.4	0.1	0.4	0.2	3.5	3.1	3.3	0.7	0.7	0.7	0.3	1.0	0.6
3	38.6	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
4	38.6	0.0	0.8	0.4	0.0	0.1	0.1	0.7	0.6	0.7	0.2	0.2	0.2	0.1	0.2	0.1
5	154.4	0.1	7.5	3.6	0.4	1.2	0.8	14.0	12.6	13.8	2.9	2.6	2.8	1.7	3.1	2.3
6	154.4	0.1	7.5	3.5	0.7	1.5	1.1	9.8	8.5	9.1	2.2	2.1	2.2	0.9	2.5	1.7
7	38.6	0.0	1.1	0.5	0.1	0.2	0.2	1.4	1.3	1.4	0.4	0.4	0.4	0.1	0.4	0.2
8	38.6	0.0	1.4	0.7	0.1	0.2	0.2	1.9	1.7	1.7	0.4	0.4	0.4	0.2	0.5	0.3
9	38.6	122.3	132.5	105.3	39.8	40.9	33.4	29.9	25.3	27.1	4.1	3.7	3.8	37.6	39.7	32.1
10	38.6	0.1	3.7	1.8	0.5	0.9	0.7	9.8	8.4	9.1	1.9	1.7	1.8	0.9	1.6	1.2
11	154.4	0.1	12.9	6.1	2.0	3.3	2.6	14.5	12.5	13.5	2.6	2.5	2.6	1.3	4.1	2.6
12	38.6	0.0	1.3	0.6	0.1	0.2	0.1	3.0	2.6	2.8	0.6	0.5	0.5	0.3	0.5	0.4
13	38.6	0.0	0.9	0.4	0.1	0.2	0.1	0.3	0.3	0.3	0.1	0.1	0.1	0.0	0.2	0.1
14	38.6	0.1	12.1	5.7	0.1	1.4	0.7	9.7	8.4	10.0	1.8	1.8	1.8	0.8	3.5	2.0
15	9.7	0.0	0.8	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
16	9.7	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
17	9.7	0.2	5.4	2.6	3.4	4.0	3.7	9.2	7.8	8.5	6.3	6.2	6.3	0.5	1.7	1.1
18	9.7	0.0	0.5	0.2	0.0	0.1	0.0	2.8	2.3	2.5	0.4	0.4	0.4	0.2	0.3	0.3
19	9.7	0.0	2.3	1.1	0.1	0.4	0.3	1.9	1.5	1.8	0.5	0.5	0.5	0.1	0.7	0.4
20	9.7	17.5	30.6	20.4	1.2	2.5	1.7	25.1	21.2	23.1	3.9	3.8	3.9	4.8	7.7	5.5
21	9.7	0.0	2.6	1.2	0.2	0.5	0.5	13.4	11.1	12.2	1.8	1.6	1.7	0.5	1.0	0.8
22	9.7	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
23	9.7	0.0	0.6	0.3	0.1	0.2	0.1	0.5	0.5	0.5	0.2	0.2	0.2	0.0	0.2	0.1
24	9.7	0.0	0.4	0.2	0.1	0.2	0.1	0.6	0.6	0.6	0.2	0.2	0.2	0.0	0.1	0.1

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TABLE 26 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES
(Continued)
TONS/YEAR

25	9.7	0.0	0.3	0.2	0.1	0.1	0.1	0.8	0.7	0.9	0.2	0.2	0.2	0.1	0.1	0.1
26	9.7	0.0	0.5	0.3	0.0	0.1	0.0	0.5	0.4	0.5	0.1	0.1	0.1	0.1	0.2	0.1
27	9.7	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
28	9.7	0.0	0.4	0.2	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.1
29	38.6	0.0	1.0	0.5	0.2	0.3	0.2	2.2	2.0	2.1	0.5	0.5	0.5	0.2	0.4	0.3
30	38.6	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	154.4	0.1	3.3	1.6	0.3	0.7	0.5	5.7	5.1	5.4	1.7	1.7	1.7	0.5	1.2	0.8
32	154.4	0.1	2.7	1.3	0.1	0.4	0.3	7.1	6.1	6.6	1.4	1.2	1.3	0.7	1.2	0.9
33	154.4	0.0	1.0	0.5	0.0	0.1	0.1	0.5	0.5	0.5	0.1	0.1	0.1	0.1	0.3	0.2
34	154.4	0.0	1.1	0.5	0.1	0.2	0.1	0.7	0.8	0.7	0.2	0.2	0.2	0.1	0.3	0.2
35	154.4	0.1	3.8	1.9	0.9	1.4	1.2	12.4	10.6	11.5	3.4	3.2	3.2	1.1	1.8	1.4
36	154.4	0.0	0.4	0.2	0.1	0.1	0.1	4.9	4.1	4.5	0.9	0.7	0.8	0.5	0.5	0.5
37	38.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	38.6	0.0	0.1	0.1	0.0	0.0	0.0	1.3	1.1	1.2	0.2	0.2	0.2	0.1	0.1	0.1
39	154.4	0.1	2.1	1.0	0.2	0.4	0.3	9.4	7.3	7.9	1.4	1.4	1.5	0.8	1.2	1.0
40	154.4	0.0	1.3	0.6	0.1	0.3	0.2	2.9	2.5	2.7	0.6	0.6	0.6	0.3	0.5	0.4
41	38.6	0.0	0.8	0.4	0.1	0.2	0.1	2.7	2.3	2.5	0.5	0.5	0.5	0.3	0.4	0.3
42	38.6	0.4	4.0	4.0	2.0	3.0	2.5	30.0	25.3	27.7	4.2	3.9	4.0	1.9	3.4	2.6
43	38.6	0.0	0.4	0.2	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
44	38.6	0.0	0.6	0.3	0.1	0.1	0.1	3.9	3.3	3.6	0.7	0.4	0.6	0.4	0.4	0.4
45	38.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	154.4	0.1	1.7	0.9	0.1	0.3	0.2	1.4	1.5	1.6	0.4	0.4	0.4	0.2	0.5	0.3
48	154.4	0.2	3.1	1.6	0.1	0.5	0.3	5.5	4.8	5.2	1.1	1.0	1.0	0.6	1.2	0.8
49	154.4	0.1	2.8	1.4	0.1	0.4	0.2	5.6	4.8	5.2	1.1	1.0	1.0	0.6	1.1	0.8
50	38.6	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	154.4	0.1	2.1	1.0	0.1	0.3	0.2	2.3	2.6	2.7	0.6	0.6	0.6	0.3	0.7	0.5

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TABLE 26 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES
(Continued)
TONS/YEAR

53	154.4	0.3	3.2	1.4	0.2	0.5	0.4	14.6	13.9	14.3	1.0	1.0	1.0	0.5	1.2	0.8
54	39.6	0.1	0.8	0.4	0.0	0.1	0.1	2.4	2.0	2.2	0.4	0.4	0.4	0.2	0.4	0.3
55	39.6	0.3	3.9	1.9	0.1	0.6	0.4	7.5	6.5	7.0	1.2	1.2	1.2	0.6	1.3	0.9
56	39.6	0.0	0.4	0.2	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0
57	38.6	0.0	0.3	0.2	0.0	0.0	0.0	0.3	0.3	0.3	0.1	0.1	0.1	0.0	0.1	0.1
58	154.4	0.1	2.4	1.2	0.1	0.4	0.2	5.0	4.3	4.6	0.9	0.9	0.9	0.5	0.9	0.7
59	154.4	0.3	5.9	2.9	1.3	2.0	1.6	4.6	4.3	4.4	1.1	1.1	1.1	0.5	1.7	1.1
60	154.4	0.1	2.1	1.0	0.1	0.3	0.2	1.7	1.5	1.6	0.4	0.4	0.4	0.2	0.6	0.4
61	38.6	0.0	1.6	0.8	0.1	0.3	0.2	3.1	2.7	2.9	0.6	0.6	0.6	0.3	0.6	0.4
62	39.6	0.0	0.6	0.3	0.0	0.1	0.1	1.3	1.1	1.2	0.3	0.2	0.2	0.1	0.2	0.2
63	154.4	0.1	5.9	2.8	0.3	0.9	0.6	8.6	7.5	8.0	1.7	1.7	1.7	0.8	1.9	1.3
64	38.6	0.4	8.5	4.2	0.6	1.5	1.0	11.1	9.6	10.3	2.2	2.1	2.1	1.4	2.9	2.1
65	38.6	0.0	0.9	0.4	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.2	0.1
66	38.6	0.0	0.8	0.4	0.0	0.1	0.1	1.9	1.6	1.7	0.3	0.3	0.3	0.2	0.3	0.2
67	38.6	0.0	0.9	0.4	0.0	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.0	0.2	0.1
68	154.4	0.0	1.6	0.7	0.1	0.2	0.2	2.5	2.2	2.3	0.5	0.5	0.5	0.2	0.5	0.4
69	38.6	0.0	0.5	0.2	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1
70	38.6	0.0	0.6	0.3	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
71	154.4	0.4	5.6	2.9	1.0	1.5	1.2	8.2	7.2	7.7	1.9	1.9	1.8	0.9	1.9	1.3
72	154.4	0.1	9.0	3.9	0.4	1.3	0.9	10.5	9.0	9.9	1.9	1.8	1.9	1.0	2.5	1.7
73	154.4	0.0	3.9	1.9	0.2	0.6	0.4	2.7	2.6	2.7	0.7	0.7	0.7	0.3	1.0	0.6
74	154.4	0.0	1.7	0.8	0.1	0.3	0.2	5.3	4.6	5.0	1.1	1.0	1.1	0.5	0.8	0.6
75	154.4	0.1	7.4	3.5	0.3	1.4	0.8	6.4	6.0	6.2	1.4	1.5	1.4	0.6	1.7	1.1
76	154.4	36.7	42.3	42.2	26.9	30.2	28.9	41.9	35.2	38.9	6.2	5.9	6.0	13.0	17.5	13.3
77	154.4	0.3	3.1	1.5	2.0	2.4	2.2	7.0	5.1	6.5	1.5	1.4	1.4	0.8	1.3	1.0
78	154.4	0.1	23.0	10.4	0.6	4.9	2.6	14.4	14.5	14.4	3.1	3.5	3.3	1.4	3.4	2.3
79	9.7	0.2	1.5	0.8	0.5	0.8	0.6	8.3	8.0	8.1	2.1	2.0	2.0	0.4	0.5	0.5
80	9.7	0.1	18.5	8.7	0.5	4.2	2.3	16.7	15.8	16.2	2.2	2.5	2.4	1.0	2.5	1.7

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TABLE 26 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES
(Continued)
TONS/YEAR

81	9.7	0.0	6.1	2.9	0.0	1.3	0.6	5.5	6.0	6.2	0.9	0.9	0.9	0.4	0.9	0.6
82	9.7	0.0	1.6	0.7	0.0	0.3	0.2	0.1	0.3	0.2	0.1	0.1	0.1	0.0	0.2	0.1
83	9.7	0.0	1.4	0.7	0.0	0.3	0.2	1.1	1.1	1.1	0.2	0.2	0.2	0.1	0.2	0.2
84	9.7	0.1	30.8	14.5	0.8	7.1	3.9	37.5	37.1	37.2	2.6	3.2	2.9	1.0	3.7	2.3
85	9.7	0.1	30.9	14.5	0.7	6.9	3.6	23.4	22.4	22.9	2.8	3.4	3.1	0.9	3.7	2.2
86	9.7	0.0	2.8	1.3	0.1	0.6	0.3	0.2	0.5	0.4	0.1	0.2	0.2	0.0	0.3	0.1
87	38.6	0.1	25.2	11.8	0.1	5.2	2.5	10.7	11.5	11.0	1.9	2.5	2.2	0.9	3.1	2.0
88	9.7	0.1	18.4	8.7	0.1	3.9	1.8	13.6	13.1	13.3	1.9	2.2	2.0	0.8	2.4	1.6
89	9.7	0.0	3.0	1.4	0.1	0.7	0.3	1.3	1.4	1.3	0.3	0.4	0.3	0.1	0.4	0.2
90	9.7	0.0	1.2	0.6	0.0	0.3	0.1	0.8	0.8	0.8	0.2	0.2	0.2	0.1	0.2	0.1
91	9.7	0.0	1.0	0.5	0.0	0.2	0.1	1.3	1.4	1.7	0.3	0.3	0.3	0.2	0.2	0.2
92	38.6	132.0	124.4	101.7	8.5	8.7	7.1	2.9	2.9	2.6	0.9	0.8	0.7	25.4	25.7	21.1
93	38.6	0.3	2.2	1.1	0.1	0.4	0.2	1.8	1.7	1.3	0.5	0.5	0.5	0.2	0.6	0.3
94	154.4	0.4	30.4	14.5	0.4	4.1	2.1	55.3	47.2	51.2	8.4	7.8	8.1	3.9	9.5	6.5
95	154.4	0.1	4.3	2.0	0.2	0.9	0.5	5.4	4.9	5.1	1.1	1.1	1.1	0.5	1.0	0.7
96	154.4	0.0	5.0	2.4	0.1	1.1	0.4	4.0	3.8	3.9	0.8	0.8	0.8	0.4	0.8	0.6
97	38.6	0.0	1.7	0.8	0.1	0.3	0.2	1.2	1.1	1.1	0.3	0.4	0.3	0.1	0.5	0.3
98	38.6	0.0	1.1	0.5	0.1	0.2	0.1	0.8	0.8	0.8	0.2	0.2	0.2	0.1	0.3	0.2
99	154.4	0.1	5.8	2.8	0.4	1.1	0.8	11.3	9.9	10.6	2.3	2.2	2.3	1.1	2.1	1.5
100	154.4	0.0	1.1	0.5	0.1	0.2	0.1	1.2	1.1	1.2	0.3	0.3	0.3	0.1	0.3	0.2
TOTAL		306.3	741.0	456.7	101.7	167.2	119.1	626.4	559.3	590.9	110.9	109.4	109.5	121.4	188.8	139.3

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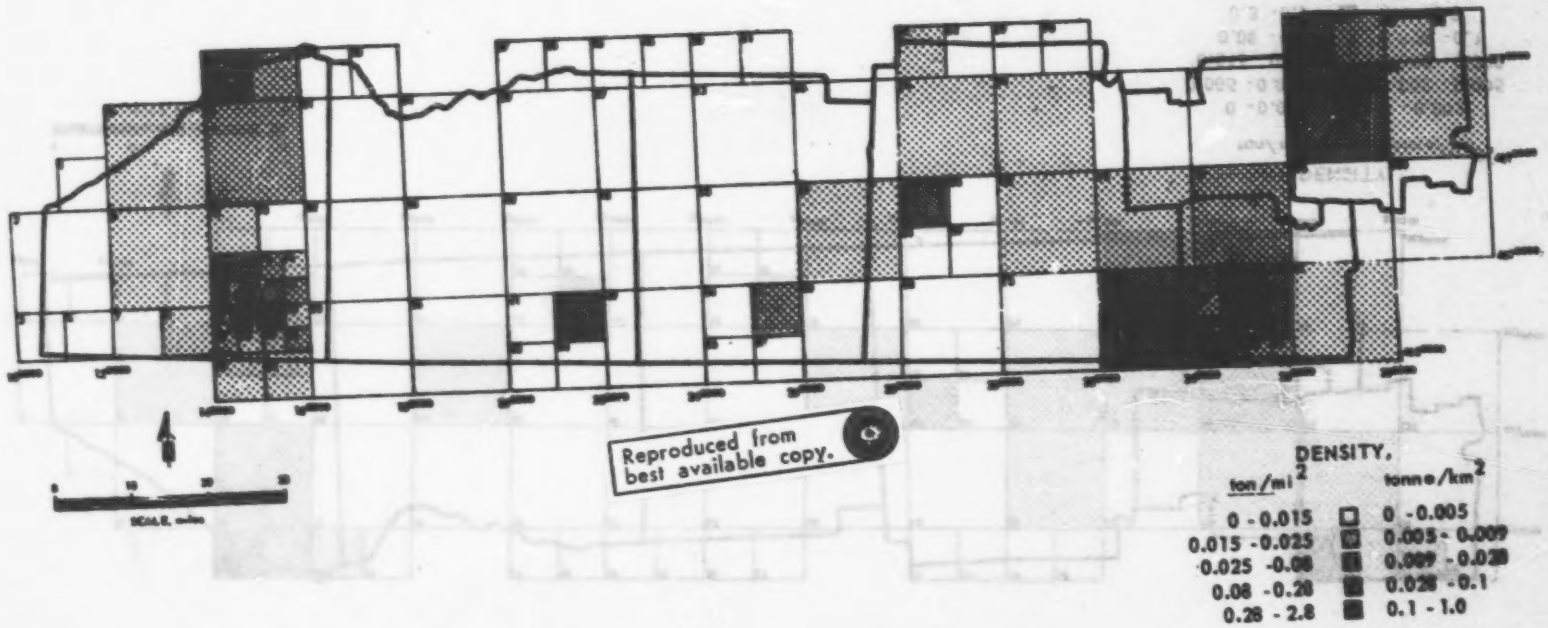

Figure 6. Sulfur oxide emission density from all sources in study area.

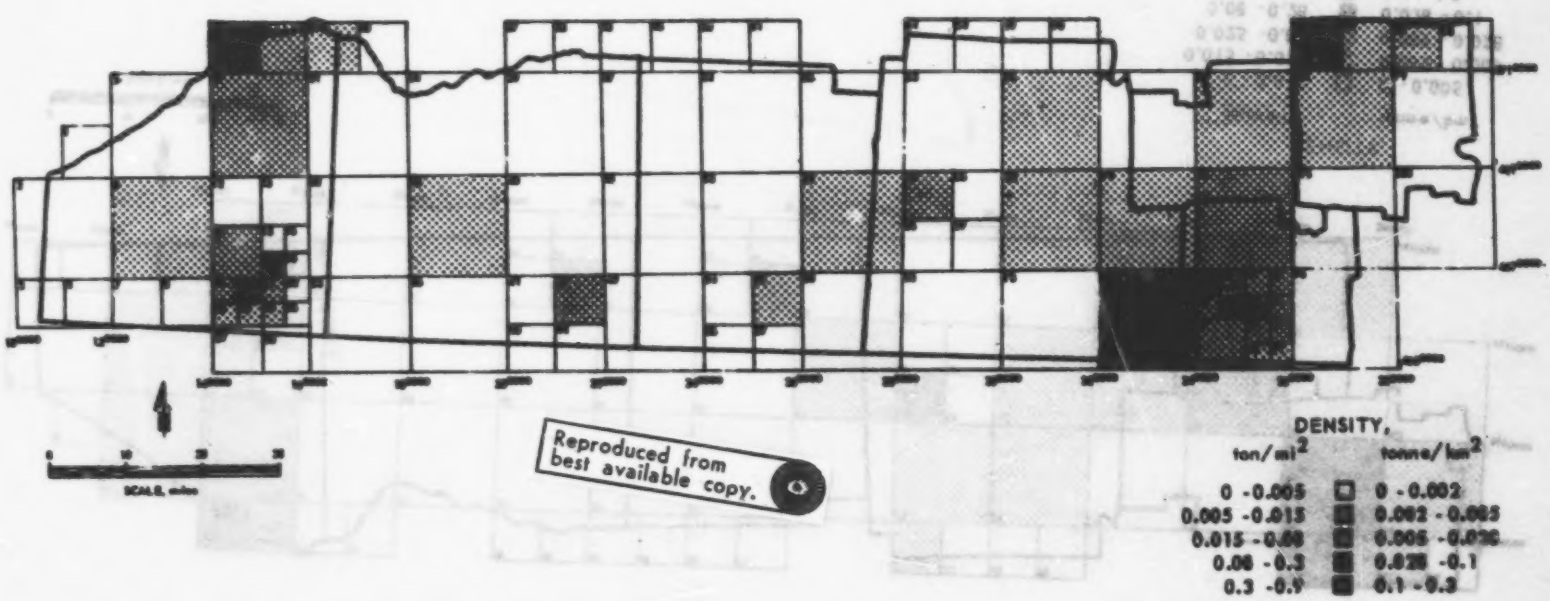

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Figure 7. Particulate emission density from all sources in the study area.

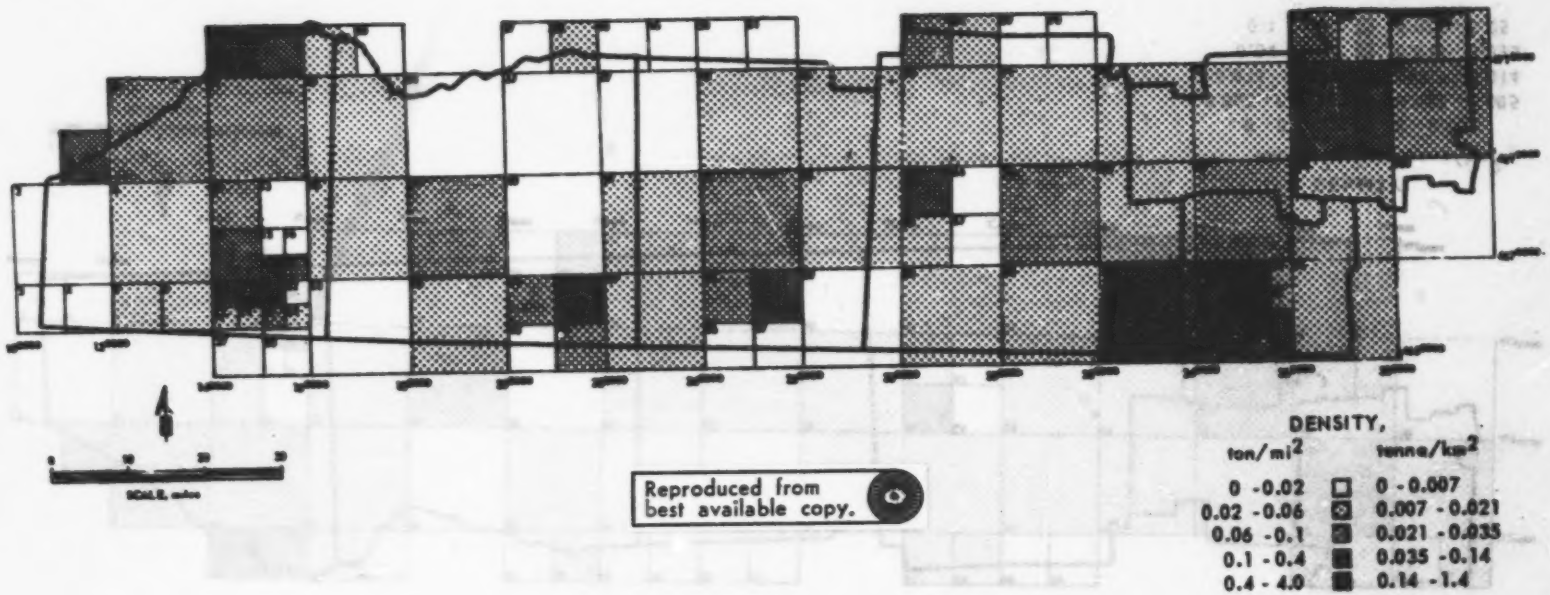

Figure 8. Carbon monoxide emission density from all sources in study area.

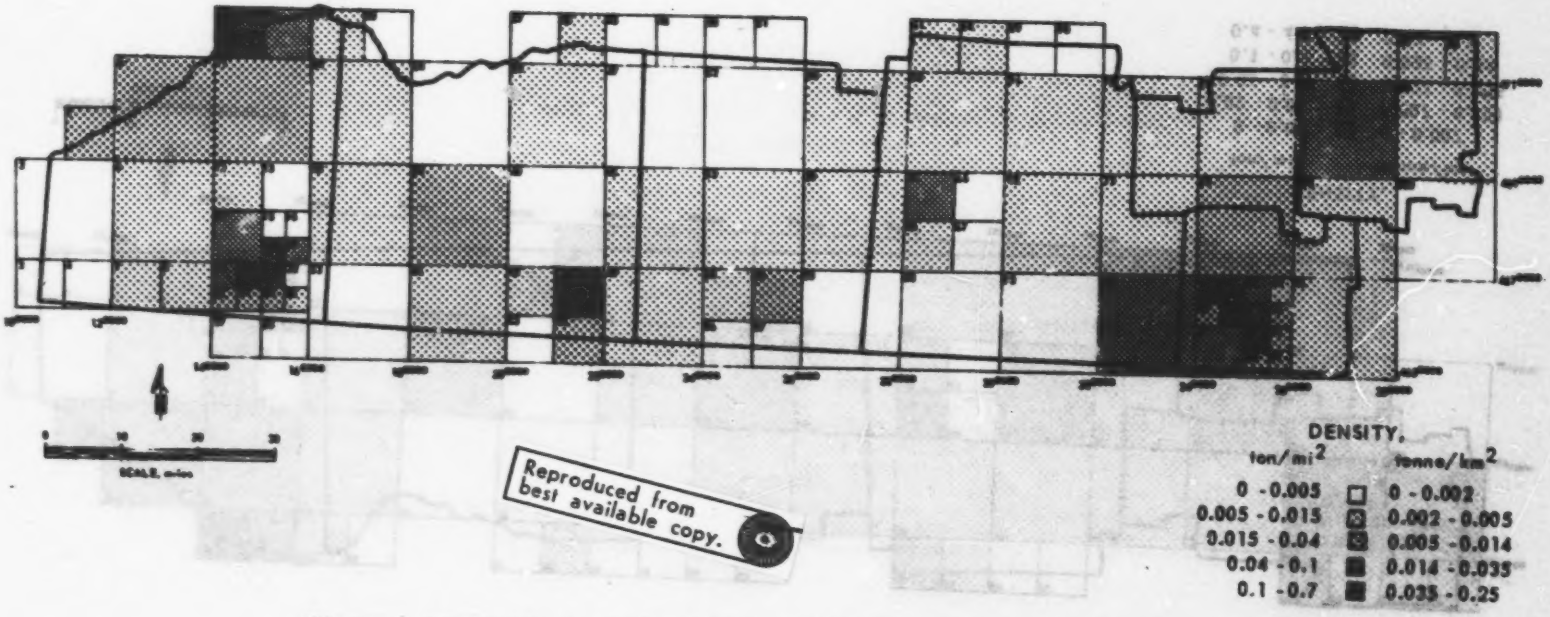

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Figure 9. Hydrocarbon emission density from all sources in the study area.

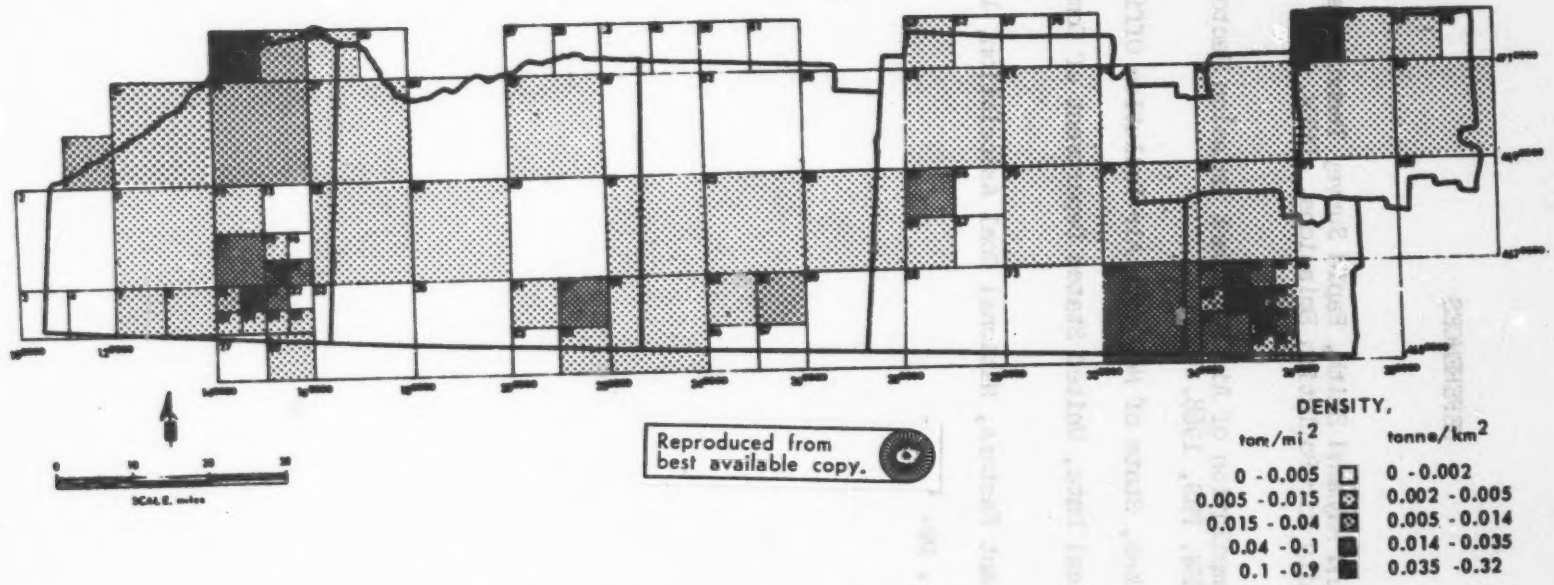

Figure 10. Nitrogen oxide emission density from all sources in the study area.

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6. Ozolins, op. cit., pp. 43-45.

APPENDIX A

METHOD FOR CALCULATING SUMMER, WINTER AND ANNUAL AVERAGE EMISSIONS FOR FUEL CONSUMPTION IN STATIONARY SOURCES

YEARLY AVERAGE (A)

$$A = \frac{\text{Fuel Consumed} \times \text{Emission Factor (E. F.)}}{\text{Days of Operation}}$$

e.g. A plant consumed 100,000 tons of coal in 1967 while operating 365 days. The total degree days for the area was 4,800 and 2,800 for the three winter months. The plant was estimated to use 15 percent of the fuel for space heating and 85 percent for process heating. From this information, the annual average emission for carbon monoxide would be the following:

$$A = \frac{100{,}000 \text{ Tons/year} \times 3 \text{ lbs. CO/Ton coal}}{365 \text{ Days/year} \times 2{,}000 \text{ lb./Ton}}$$

$$A = 0.41 \text{ Ton/Day}$$

WINTER AVERAGE (W)

$$W = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Winter Operation}} \times \frac{\text{Winter Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$W = \left[\frac{100{,}000 \times 2{,}800}{90 \times 4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$W = 0.49 \text{ Ton/Day}$$

SUMMER AVERAGE (S)

$$S = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Summer Operation}} \times \frac{\text{Summer Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$S = \left[\frac{100{,}000}{90} \times \frac{0}{4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$S = 0.35 \text{ Ton/Day}$$

APPENDIX B

METRIC CONVERSION FACTORS

Multiply	By.	To Obtain
Feet	0.3048	Meters
Miles	1609	Meters
Square Feet	0.0929	Square meters
Square Miles	2.59	Square kilometers
Pounds	453.6	Grams
Pounds	$453.6/10^4$	Tons (metric)
Tons (metric)	1.103	Tons (short)
Tons (short)	907.2	Kilograms
Tons (short)	.9072	Tons (metric)

To Obtain	By	Divide